SYNOPSIS OF THE GENUS *LYCORIS* (AMARYLLIDACEAE)

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ABSTRACT

Species of the East Asian genus *Lycoris* are easily hybridized; diverse morphological features occur frequently among them in nature and in cultivation. This has caused much difficulty in identifications. Based on taxonomic and karyological investigations and crossing tests, 20 species are recognized of which four are regarded as hybrids: *Lycoris ×haywardii*, *L. ×albiflora*, *L. ×houdyshelii*, and *L. ×rosea*. *Lycoris aurea* var. *angustitepala* is proposed as new. Keys, descriptions, synonymies, typifications, and karyotypes are included.

RESUMEN

Las especies del este asiático del género *Lycoris* se hibridan fácilmente y diversas características morfológicas se dan frecuentemente tanto en la naturaleza como en cultivo. Esto ha causado mucha dificultad en las identificaciones taxonómicas. En base a investigaciones taxonómicas y cariológicas, así como pruebas de cruzamiento, se han reconocido veinte especies de las que cuatro son consideradas como híbridos. *Lycoris ×haywardii, L. ×albiflora, L. ×houyshelii y L. ×rosea.* Por otro lado, L. aurea var. angustitepala se propone aquí como nueva. Se incluyen claves, descripciones, sinonimias, tipificaciones y cariotipos.

The genus *Lycoris* Herb. consists of 20 species distributed in warm temperate to subtropical zones of East Asia from southwestern China to Japan and southern Korea, with a few extending to northern Indochina and Nepal. The species are easy to hybridize with each other, and a number of the presently recognized taxa are certainly of hybrid origin.

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Introduction and cultivation of *Lycoris* species began in the 18th century, first to England and then to the United States. To date, most of the species have proven successful in cultivation. They are summer- and autumn-blooming plants of great beauty and common in the gardens of China, Japan, and the United States. In comparison with other well-known bulb flowers, such as narcissi and lilies, *Lycoris* has its own characteristics and merits. *Lycoris* comes into flower at a time when few other bulbous plants are active. The flowers are characterized by their pastel and plentiful colors as well as by beautiful and varied shapes. The plants are tolerant to drought, waterlogging, and pests, growing vigorously even in barren land, and thus show good prospects in horticulture.

The genus *Lycoris* was founded by Herbert in 1821, and *L. aurea* (L'Hér.) Herb. was assigned to be the type. In the mid 19th to the early 20th century, nine new species were published by various European authors: *L. africana* (Lam.) M.J. Roem. (1847), *L. straminea* Lindley (1848), *L. sewerzowii* Regel (1868), *L. squamigera* and *L. sanguinea* Maximowicz (1885), *L. terraccianii* Dammann (1889), *L. sprengeri* Comes ex Baker (1902), *L. incarnata* Comes ex Sprengel (1906), and *L. argentea* Worsley (1928). In the first half of the 20th century, three new species from Japan were added: *L. albiflora* Koidzumi (1924), *L. koreana* Nakai (1930), and *L. kiusiana* Makino (1948). After that, the American botanist Hamilton P. Traub focused his research on the tribe Amarylleae, Amaryllidaceae, and published 10 new species (two with Moldenke) of *Lycoris* based mainly on materials introduced from China and Japan and cultivated in American gardens: *L. rosea* (1949); *L. haywardii*, *L. caldwellii*, *L. houdyshelii*, and *L.* ×*woodii* (1957); *L. chinensis* and *L. elsiae* (1958), *L.* ×*lajolla* (1963), *L.* ×*jacksoniana* (1964); and *L. josephinae* (1965). Two keys to the species of the genus were presented in his two issues (Traub 1957, 1958). Two American horticulturists, Hayward and Caldwell, had done much of work on introduction and cultivation of *Lycoris* species. Hayward (1957) published a new species: *L. traubii*. After an interval of about 15 years, the Chinese botanists Hsu & Fan (1974) and Xu et al. (1982) published four new species of *Lycoris* from China: *L. longituba*, *L. anhuiensis*, *L. guangxiensis*, and *L. shaanxiensis* (1982). Their revision of the Chinese *Lycoris*, in which 15 species were included, was published in *Flora Reipublicae Popularis Sinicae* (1985). Recently, M. Kim and S. Lee (1991) published a new species, *L. flavescens*, in their study of Korean *Lycoris*. To date then, 29 species have been published. However, some of these have been reduced to synonyms, some to infraspecific rank, and still some are cultivars or hybrids. Twenty species are included in the present paper, though the identity of a few of them is still equivocal and deserves further study. A number of species published in the earlier period are without indications of type specimens or even precise type localities; many type specimens are not available to us. Besides, the classification of the genus *Lycoris* is largely based on morphology and color of flowers; leaf morphology is not of much value in identifications. Furthermore, *Lycoris* species are easy to hybridize

with each other, and hybrids of diverse morphological features occur frequently in nature and in cultivation. All this has caused great difficulties in our research work. In many cases, karyological investigation furnishes a taxonomic identification with solid data.

Lycoris belongs to the subtribe *Lycorinae* of the tribe *Amarylleae* of subfamily *Amaryllidoideae*. *Ungernia* Bunge, the only other genus of the subtribe, differs from *Lycoris* mainly in its stamens inserted in two rows instead of one row near the throat of the tepaltube, and in its basic chromosome number, x=11. *Ungernia* has six species with a distribution confined to Iran and central Asia.

Lycoris was divided by Traub and Moldenke (1949) into two subgenera based largely on flower form and length of stamens. Species of subgen. *Symmanthus* Traub & Moldenke have wide tepals that are erect or recurved only at the tips, with the distal part more like a trumpet lily. In this subgenus, some species have slightly wavy-margined tepals, but the majority do not. Fragrance is found only among the funnel-form species. Species of subgen. *Lycoris* have spiderlily-form flowers with substantially reflexed tepals, and the stamens and style usually long-exserted. The tepals are almost invariably crisped, wavy, or undulate. The flowers are not fragrant.

Phenologically, the species of *Lycoris* may be divided into two types. Those species from areas with colder winters make little or no leaf growth until January or later. Those species from areas with warmer winters make leaf growth in the autumn and remain in active growth all winter. In both cases, leaf growth continues actively until late spring, whereupon the leaves die back. The plants are leafless during summer.

Cytological studies on *Lycoris* were initiated in the late 1920s. To date, chromosome number determination and karyotype analyses have been made for most of the species. There are three major chromosome types: (1) M (metacentric chromosomes); (2) A (acrocentric chromosomes); and (3) T (telocentric chromosomes). In the species with $2n=22$, all rod chromosomes are As; in the species with $2n=12–16$, all rod chromosomes are Ts. The genus has a series of basic chromosome numbers—6, 7, 8 and 11—but the total number of arms of a chromosome complement of any species is always multiples of 11. It seems that 11 is the primitive basic chromosome number (Liu & Hsu 1989). However, it is still unresolved whether a successive decrease in chromosome numbers as a result of Robertsonian fusion or a gradual increase in chromosome numbers brought about by centric fission has been the essential mechanism for karyotype evolution and speciation in the genus. Hsu and Liu (1987) proposed a new "fusion-fission synthetic theory" for explaining the karyotype evolution and speciation in *Lycoris*. The theory embodies three central ideas: (1) the basic chromosome number of *Lycoris* is x=11, and $2n=22$ is the primitive karyotype; (2) both fusion and fission have taken place, at different times during the process of karyotype evolution; and (3) duplications, translocations, and other chromosome aberra-

tions must have occurred in the process of fusion. The meiotic behavior of the diploid hybrid *L.* aff. *albiflora* gives evidence for the assumption that Robertsonian changes have occurred in the process of karyotype evolution (Liu & Xu 1990). Kurita (1988b), however, insisted that the M type chromosome is not a simple product of the fusion of two A type chromosomes. Based on karyological and karyogeographical evidences, together with C-banding patterns and DNA contents of certain species, he is inclined to the fission theory.

Much work on hybridization and breeding was accomplished mainly by horticulturists from the United States, Japan, and China in the past 50 years. In the early 1940s, Wood (cf. Adams 1976) crossed *L. radiata* with *L. traubii*, creating the hybrid *L.* ×*woodii* Traub. Creech (1952) reported the pollination of *L. radiata* by *L. aurea;* the resulting hybrid had $2n=19$. Takemura (1961, 1962a,b) made a series of artificial crosses between *L. sprengeri*, *L. straminea* (probably not true *L. straminea*), *L. radiata*, *L. radiata* var. *pumila*, *L. sanguinea,* and *L. aurea*, and investigated morphology and cytology of the hybrids. Caldwell (1972, 1981) made many crosses beginning in 1954. One beautiful Caldwell hybrid is *L. jacksoniana* (Traub 1964), the parental species of which are *L. sprengeri* and *L. radiata*. Koyama (1962) observed meiotic behavior of that hybrid. Adams (1976) made numerous crosses, mostly repeating those that had been done before. Lin et al. (1990, and unpub.) have been successful in bringing forth new hybrids and have shown that both *L. rosea* and *L. haywardii* are hybrid segregates of *L. radiata* var. *pumila* ♀ × *L. sprengeri* ♂, and that *L. squamigera* is the hybrid of *L. chinensis* ♀ × *L. sprengeri* ♂. One new hybrid resulting from *L. sprengeri* ♀ × *L. chinensis* ♂, which they have named *L.* ×*elegans*, ined. resembles *L. albiflora* in general appearance, but its karyotype is $2n=3M+16A=19$. Diploid species of *Lycoris* are easy to hybridize with each other, irrespective of their conspicuous morphological and ecological differences. The fertility of these hybrids is high (Lin et al. 1990). The properties of hybrids can be maintained by means of vegetative propagation. This is probably why hybrids often occur in nature as well as in cultivation. On the contrary, hybridizations between the triploid lycorises are generally unsuccessful (Lin et al. 1990). Results obtained from an extensive interspecific crossing program involving reciprocal combinations of many species by Xu et al. (1986) have shown that both pollen viability and seed-set after crossing are correlated with ploidy level.

Only a few palynological studies of *Lycoris* have been carried out. Kurita (1985) found that there was a latitudinal topocline of variation in pollen ornamentation as well as in the amount of gemmate protrasion on the foot layer of pollen grains within *Lycoris sanguinea* var. *sanguinea* in Japan. As a result of a palynological study of five species of *Lycoris* from southern Korea, Lee and Kim (1987) conclued that pollen size, muri thickness, lumina size, and lumina number per 100 μm^2 of these species were fundamentally in direct proportion to number and size of chromosomes.

Because many investigations of karyology, morphological variation, distribution patterns, and breeding of *Lycoris* species have been carried out in recent years, Traub and Moldenke's revision (1949) requires modification. It is hoped that the present revision of the genus will contribute to this objective.

LYCORIS Herb., Bot. Mag. 47:t.2113. 1821. Benth. & Hook.f., Gen. Pl. 3:727. 1883; Maxim., Bot. Jahrb. 6:73. 1885; Baker, Handb. Amaryll. 39. 1888; Spreng., Bull. Soc. Tosc. Ortic. 8:323. 1888; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 165. 1949; Traub, Pl. Life 13:42. 1957 & l.c. 14:42. 1958; Ohwi, Fl. Jap. 383. 1978; Hsu et al., Fl. Reipub. Pop. Sin. 16:16. 1985; Kim & Lee, Korean J. Pl. Taxon. 21:3. 1991.

Bulbous perennial herbs. Leaves after or before the flowers, strap-shaped or linear, basal, dying away before flowers develop. Flowers showy, red, yellow, peach, lilac and blue, or white (intermediates and pastel tones of the colors are also present in some species and hybrids), subtended by 2 spathe-valves, in an umbel on a solid scape; perigone 6-lobed, funnel-form and regular or spiderlily-form and irregular; tepaltube short but expanded at top, throat bearing scales; tepals clawed, reflexed at the tips or not; stamens 6, inserted near throat, declinate, exserted or not; style long, with a very small capitate stigma, ovary inferior, 3-loculed, ovules few in each locule, placentation axile. Fruit a loculicidal capsule; seeds few, round, smooth, black.

There are about 20 species native to China, Japan, and southern Korea, with a few extending southwestward to northern Indochina and Nepal.

1. Flowers funnel-form, regular; tepals not crisped-margined or only minutely wavy at base, erect or slightly recurved at the tips; stamens included or slightly exceeding tepals (Subgen. *Symmanthus* Traub & Moldenke).
   2. Leaves appearing in early spring or in autumn; flowers tinged with blue in various degrees.
      3. Leaves appearing in early spring.
         4. Flowers produced in Aug.–Sep., vivid rose in the throat, ink-blue at the tips of tepals, otherwise purplish rose (China) ..... 1. *L. sprengeri*
         4. Flowers produced in Jul.–Aug., bluish-mauve with a deeper mauve keel (Upper Burma) ..... 2. *L. argentea*
      3. Leaves appearing in autumn; flowers produced in Jul.–Aug., reddish violet with a deeper keel and changing to ink-blue at tips of tepals (China, Japan, only cult.) ..... 3. *L.* ×*haywardii*
   2. Leaves usually appearing in early spring; flowers never tinged with blue.
      5. Leaves 1–1.2 cm broad, without a distinct whitish stripe; tepaltube 1–2.5 cm long; flowers flesh-colored or light rose.
         6. Flowers light purplish pink; tepals 6.3–7 cm long (China, Japan, Korea). ..... 4. *L. squamigera*
         6. Flowers not light purplish pink; tepals 5–7 cm long.
            7. Flowers white, changing to flesh-colored or light rose; tepals with a reddish band above and a deeper keel below, 5–5.6 cm long (China) ..... 5. *L. incarnata*
            7. Flowers apricot-orange or rarely white; tepals 6.4–7 cm long.

8. Tepals slightly recurved; stamens shorter than or subequalling tepals; flowers in late Jul.–Aug. (Japan) ..... 6a. *L. sanguinea* var. *sanguinea*
8. Tepals distinctly recurved; stamens distinctly exceeding tepals.
9. Flowers 7–8 cm long (Japan) ..... 6b. *L. sanguinea* var. *kiusiana*
9. Flowers 5–6 cm long (Korea, Japan) ..... 6c. *L. sanguinea* var. *koreana*

5. Leaves 1.5–2.5 cm broad, with a distinct whitish stripe; tepaltube 2–6 cm long; flowers yellow or white.
10. Tepaltube 2–3.5 cm long; flowers yellow (China) ..... 7. *L. anhuiensis*
10. Tepaltube 4.2–6 cm long; flowers yellow or white to peach-colored.
11. Flowers white with light reddish stripes or peach-colored in bud and opening pinkish (China) ..... 8a. *L. longituba* var. *longituba*
11. Flowers yellow (China). ..... 8b. *L. longituba* var. *flava*

1. Flowers spiderlily-form or nearly so, distinctly irregular; tepals strongly or medium crisped-margined, strongly recurved at the tips (Subgen. *Lycoris*).
12. Leaves produced in early spring; stamens shorter than to slightly exceeding tepals.
13. Leaves without a distinct whitish stripe; stamens shorter than tepals.
14. Flowers in bud peach-colored, opening to creamy yellow, changing to creamy white with age; tepals without pinkish stripes (China) ..... 9. *L. caldwellii*
14. Flowers white with a few pinkish stripes inside and a reddish keel underside of each tepal (China) ..... 10. *L. shaanxiensis*
13. Leaves with a distinct whitish stripe; stamens subequalling or slightly exceeding tepals; flowers yellow.
15. Leaves narrow strap-shaped, dark green, 24–29 cm long, 1–1.2 cm broad; tepals with reddish bands (China) ..... 11. *L. guangxiensis*
15. Leaves strap-shaped, green, ca. 35 cm long, ca. 2 cm broad; tepals without reddish bands ..... 12. *L. chinensis*

12. Leaves produced in autumn; stamens usually far exceeding tepals.
16. Leaves more than 12 mm broad; flowers various colored, but never red.
17. Flowers yellow.
18. Remains of leaf-bases prominent at the base of scape; flowers somewhat upright, cadmium yellow; tepals with a pale green band underside, narrowly elliptic, 8–12 mm broad; spathe-valves lanceolate, 7–8 cm long; pedicels 15–22 mm long.
19. Tepals 7–12 mm broad.
20. Tepals distinctly recurved (China, Burma) ..... 13a. *L. aurea* var. *aurea*
20. Tepals upright (Upper Burma) ..... 13b. *L. aurea* var. *surgens*
19. Tepals 4–8 mm broad (China) ..... 13c. *L. aurea* var. *angustitepala*
18. Remains of leaf-bases not prominent at the base of scape; flowers more or less horizontally spreading, rich orange-yellow; tepals with a deeper orange-yellow band underside, narrow oblanceolate, 13–16 mm broad; spathe-valves ovate, 3.5 cm long; pedicels 8–9 mm long (Japan, Korea, China: Taiwan) ..... 14. *L. traubii*
17. Flowers pale straw-colored, creamy white to white, or salmon-colored.
21. Flowers creamy-white to white or pale straw-colored.
22. Flowers creamy white to white.
23. Flowers pinkish in bud, opening creamy white, changing to white with age; tepals with a very light orange-

yellow band in the center; tepaltube ca. 2 cm long (Japan, Korea, China) ..... 15. *L.* ×*albiflora*

23. Flowers creamy white, changing to whitish; tepals with a greenish band underside; tepaltube ca. 8.5 mm long (China) ..... 16. *L* ×*houdyshelii*

22. Flowers pale straw-colored; tepals with a pink band and a few scattered red dots in the upper surface, changing to white in full blossom; tepaltube 4–5.5 mm long (China) ..... 17. *L. straminea*

21. Flowers salmon-colored, finally fading to a flesh-color; tepals with a deep purplish band tinged with creamy and yellow along the center; tepaltube 12–13 mm long (Japan). ..... 18. *L. elsiae*

16. Leaves less than 9 mm broad; flowers bright red or rose-colored.

24. Flowers bright red or sometimes with white-margined tepals; tepals distinctly crisped-margined and strongly reflexed; stamens 2–2.5 times the length of tepals.

25. Flowers bearing no seeds (China, Japan, Korea, Nepal) ..... 19a. *L. radiata* var. *radiata*

25. Flowers bearing seeds (China) ..... 19b. *L. radiata* var. *pumila*

24. Flowers rose-colored, pale red, or becoming whitish; tepals not crisped-margined or only ruffled at the base, slightly reflexed; stamens a little longer than tepals.

26. Flowers pale red or becoming whitish, with tepals 1.5–3.2 cm long and 2–5 mm broad (Japan) ..... 19c. *L. radiata* var. *kazukoana*

26. Flowers rose-colored, with tepals 4–6 cm long and 7–8 mm broad (China) ..... 20. *L.* ×*rosea*

1. **Lycoris sprengeri** Comes ex Baker, Gard. Chron. ser. 3, 32:469. 1902. Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 170. 1949; Traub, Pl. Life 13:43. 1957, in clavis; Hsu et al., Fl. Reipub. Pop. Sin. 16(1):24. 1985. TYPE: HUBEI PROVINCE: mountains near Xiangyang, not indicated. Sprenger (1906, cf. Traub & Moldenke 1949) stated this species was sent to him by his collector from China about 1900. They (1949) remarked that Comes' reference, which had never been found, was probably a specimen label.

Leaves ensiform-linear, ca. 30 cm long and 1 cm broad, dark green. Perigone vivid rose in the throat, otherwise purplish rose with ink-blue tips on the tepals. Tepaltube 1.2–2.3 cm long; tepals oblanceolate, 4.5–7 cm long, 1–1.7 cm wide, not ruffled-margined, recurved. Stamens somewhat shorter than tepals. Style about as long as or slightly exceeding tepals.

Phenology: leaves appearing in early spring; scape produced in August to September.

Karyotype: $2n = 22A = 22$ (Kurita 1987a; Liu & Hsu 1989).

Distribution: endemic to China (Anhui, Hubei, Jiangsu, Zhejiang). In bamboo groves and on moist slopes in sparse woods; ca. 100 m.

Specimens examined: CHINA. **Anhui:** Chuxian, Langya Shan, *East China Bot. Station 3114* (JSBI). **Jiangsu:** Yixing, *W.Z.Fang 297* (PE); *Y.L.Keng 2559* (JSBI); Jiangning, *J.S.Yue 0561*(JSBI); Shanghai, Tianma Shan, *G.J. Fan s.n.* (PE); same locality, Heng Shan, *G.J.Fan s.n.*

(PE); *S.S.Su 253* (JSBI); *Nanjing Univ. Exped. 253* (SZ); same locality, Songjiang, *G.J.Fan s.n.* (PE); without precise locality, *W.C.Chow 819* (FUS). **Zhejiang:** Xiaoshan, *Y.L.Keng 1111* (FUS); Hangzhou, Hangzhou Bot. Gard. cult., *Z.Z. Yu 004, 012, 013* (HZBG); Zhoushan, *J.Z.Lin 008* (HZBG).

This species shows much variation in breadth of tepals and in lengths of tepaltube and stamens. The plants coming from Zhoushan, Zhejiang, show some differences in length of stamens, some with stamens shorter or subequalling the tepals, some with longer and exserted stamens.

2. **Lycoris argentea** Worsley, Gard. Chron. ser. 3, 84:169, fig. 72. 1928. Grey, Hardy Bulbs 2:57. 1938; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 169. 1949. TYPE: not indicated. Worsley (1928) remarked that the type material was sent to the Royal Horticultural Society, England, in October 1904 by C. Judes from Upper Burma.

Leaves bluish green. Perigone bluish mauve with a silvery sheen and some sparkles and a deeper mauve keel. Tepaltube very short; tepals oblong, neither undulate-margined nor recurved. Stamens and style subequalling tepals.

Phenology: leaves appearing in autumn; scape produced in July to August.

Karyotype: no reports.

Distribution: Upper Burma.

The above morphological description is based on Worsley's brief description of the type. No other detailed information is available. According to Worsley (1928), this species differs from *L. squamigera* Maxim. in having bluish-mauve tepals with a deeper mauve keel, and in the stamens and style being about equal to the tepals. We have not seen any specimens of this species at Kew. It has probably a more close affinity to *L.* ×*haywardii* than to *L. squamigera*, at least in morphology. At present, the identity of this species, be quite equivocal, deserves further study.

3. **Lycoris** ×**haywardii** Traub (pro sp.), Pl. Life 13:44, fig. 16. 1957. Caldwell, Pl. Life 13:53. 1957. TYPE: UNITED STATES. TENNESSEE: Nashville (cult.), *S. Caldwell 554* (HOLOTYPE: TRA). PARATYPE: FLORIDA: Winter Park, *W. Hayward 291* (TRA). According to Caldwell (1957), the type was from Japan.

Leaves up to 48 cm long, 7–11 mm broad, deep green, glaucescent. Perigone reddish violet, a little lighter than in *L. sprengeri*, tepals with a deeper keel and changing to ink-blue at the apex. Tepaltube 1.1–1.3 cm long; tepals oblanceolate, 4.4–5.5 cm long, 1–1.1 cm broad, not crisped-margined. Stamens somewhat shorter than tepals. Style moderately exserted.

Phenology: leaves appearing in autumn; scape produced in July to August.

Karyotype: $2n = 22A = 22$ (Hsu et al. 1981; Liu & Hsu 1989).

Distribution: known only in cultivation.

Specimens examined: CHINA. **Zhejiang:** Hangzhou, Hangzhou Bot. Gard., cult., *J.Z.Lin 002, 003, Z.Z.Yu 026* (HZBG). The specimens cited differ from the type in having longer stamens exceeding the tepals.

This species is most closely allied with *L. sprengeri* Comes ex Baker and differs from that species mainly in having smaller flowers with a paler bluish purple color and an earlier blooming time.

Hybridizing tests accomplished by Lin et al. (unpub.) have shown that *L.* ×*haywardii* is a hybrid between *L. sprengeri* and *L. radiata* var. *pumila*. The artificial hybrids resemble *L.* ×*haywardii* very much in external morphology. Karyologically, both of the parental species have $2n=22A$, also in accord with *L.* ×*haywardii*.

4. **Lycoris squamigera** Maxim., Bot. Jahrb. 6:79. 1885. Baker, Handb. Amaryll. 40. 1888; Bot. Mag. 123:pl.7547. 1897; Spreng., Bull. Soc. Tosc. Ortic. 8:327. 1888; Nakai, Fl. Kor. 234. 1911; Worsley, Gard. Chron. ser. 3, 84:169. 1928; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 173. 1949; Koyama, Baileya 7:6, fig. 18. 1959; Ohwi, Fl. Jap. ed. 2,384. 1978; Hsu et al., Fl. Reipub. Pop. Sin. 16(1):24. 1985; M.Kim & S.Lee, Korean. J. Pl. Taxon. 21:10. 1991. TYPE: JAPAN: Maximowicz cited three specimens from Japan, two of which were from a locality near Oyo of Simabara Pref., Kiusiu, with a shady seashore habitat, and one of which was cultivated in Yokohama. No mention about the collectors of the type material.

Amaryllis hallii Hovey ex Baker, Bot. Mag. 123:t.7547. 1897, in syn.

Leaves 1.8–2.5 cm broad, bright green. Perigone light purplish pink with a gold throat. Tepaltube 1.6–2.5 cm long; tepals oblanceolate, 6–7 cm long, 1.2–1.8 cm broad, minutely wavy-margined at base, not reflexed. Stamens subequalling tepals. Style slightly exserted.

Phenology: leaves appearing in spring in Japan and Korea, in autumn in China, then dying down and regenerating in spring; scape produced in August.

Karyotype: $2n=6M+10T+11A=27$ (Kurita 1987a; Liu & Hsu 1989).

Distribution: eastern China (Jiangsu, Shandong, Zhejiang), Japan, and Korea. In moist often disturbed places, such as margin of plantations, around dwellings, and graveyards; to 1200 m.

Specimens examined: CHINA. **Jiangsu:** Yuntai Shan, *F.X.Liu 10732* (PE); *X.R.Chang* et *al. 19608* (SHMI); Shanghai, cult., *P.S.Hsu 486* (FUS, JSBI); *C.N.Yan 10391* (FUS). **Shandong:** Qingdao, Lao Shan, *H.B.Cui 376* (PE). **Zhejiang:** Shonshan, *Y.L.Keng 1111* (FUS).

JAPAN. **Chiba Pref.:** Chiba Univ., cult., *S.Kurita 910820* (CBM). **Nagano Pref.:** Kamiminochi-gun, Tokakushi-mura, *S.Kurita 870810* (CBM). **Tokyo Pref.:** Hachioji, Kamiange, *S.Kurita 860815* (CBM).

KOREA. **Kangwon-do:** Kangwon, Mt. Kumgangsan, *T.Uchiyama s.n.* (TI). **Kyonggi-do:** Suwon, *H.Ueki s.n.* (TI).

Based on karyological and morphological studies, Inariyama (1948, 1951, 1952, 1953) considered this sterile species a triploid hybrid between *L. straminea*[2] and *L. sprengeri*. Takemura (1961) crossed *L. straminea*[2] and *L. sprengeri*. The hybrids resembled *L. squamigera* in gross morphology, but they were diploids

[2]Plants examined by Inariyama, Takemura and Kurita were *L. straminea* auct. non Lindl., and might be *L. longituba* Y. Hsu & G.J. Fan.

having $2n=19$. Based on cytological investigation, Kurita (1987a) supported Inariyama's proposition and was of the opinion that since *L. squamigera* occurs only in human habitations or as an escape in Japan, it was brought to Japan from China for ornamental purposes in early time.

5. Lycoris incarnata Comes ex Spreng., Gartenwelt 10:490, fig. 1. 1906. Worsley, Gard. Chron. ser. 3, 84:169. 1928; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 172. 1949; Traub, Pl. Life 13:43. 1957; Hsu et al., Fl. Reipub. Pop. Sin. 16(1):25. 1985. TYPE: no type specimen cited. Sprenger stated that *L. incarnata* was first described by Comes in Portici, Italy. But it has not been possible to verify this statement (Traub & Moldenke 1949). According to Sprenger, this species was collected in Hubei, China, and sent to him in Naples about 1901 by a collector.

Leaves strap-shaped, ca. 50 cm long, ca. 1.2 cm broad, dark green. Perigone white in bud, opening white, changing gradually to flesh-colored or light rose. Tepaltube 1.8–2 cm long; tepals oblanceolate, with a reddish stripe above and a deeper keel below, 5–5.6 cm long, 1.2–1.4 cm broad, barely undulate-margined, only very slightly recurved. Stamens purplish, subequalling or somewhat shorter than tepals. Style purplish, a little exceeding tepals.

Phenology: leaves appearing in spring; scape produced in September to October.

Karyotype: $2n=4M+3T+22A+1m=30$ (Kurita 1987a).

Distribution: endemic to China (Hubei and Yunnan).

This species is most similar to *L. squamigera* Maxim. from which it differs mainly in the leaves appearing only once in spring, in the size and color of flowers, and in the karyotype.

Kurita (1987a) strongly suggested that *L. incarnata* must have originated from a cross between a gamete having 4M+3T and another gamete having 22A+1m, though the parental species could not be decided.

6. Lycoris sanguinea Maxim., Bot. Jahrb. 6:80. 1885. Baker, Handb. Amaryll. 40. 1888; Spreng., Bull. Soc. Tosc. Ortic. 8:328. 1888; Worsley, Gard. Chron. ser. 3, 84:169. 1928; Makino, Illus. Fl. Jap. fig. 2165. 1949; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 175. 1949; Koyama, Baileya 7:5, fig. 2a. 1959; Ohwi, Fl. Jap. ed. 2, 384. 1978.

Lycoris cyrtanthiflora Hort. Worsley, Gard. Chron. ser. 3, 84:169. 1928; Grey, Hardy Bulbs 2:58. 1938; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 175. 1949.

6a. Lycoris sanguinea var. **sanguinea,** TYPE: Maximowicz listed two type specimens of this species in his type description. They were all from Japan: one near Yokohama (*Tschonoski* fl.), and the other between Kyoto and Maizuru (*Doederlein* fl., in Engler's Herb.). We have not been able to see these two specimens.

Leaves strap-shaped, 20–30 cm long, 10–12 mm broad, light green. Perigone apricot-orange. Tepaltube 1–1.5 cm long; tepals linear-oblong, acute, 6.4–7 cm long, ca. 3.8 cm broad, neither crisped-margined nor recurved. Stamens subequalling or slightly shorter than tepals. Style exceeding tepals.

Phenology: leaves appearing in spring, dying down and coming up again in next spring; scape produced in late July to late August.

Karyotype: $2n=22A=22$ (Inariyama 1931, 1937, 1951; Koyama 1954, 1962; Kurita 1989; Nakamura 1978; Nishiyama 1928; Sato 1942; Takemura 1961; Yoshida 1972); $2n=31A+1M=32$ (Kurita 1989).

Distribution: Japan (northern Honshu and southwestward, Shikoku, Kyushu). In moist places by streams and sparse woods; to 500 m.

Specimens examined: JAPAN. **Chiba Pref.:** Chiba, Noromachi, *S.Kurita 870810* (CBM). **Ehima Pref.:** Saijyoshi, Mt. Ishizuchi, *M.Takahashi 1790* (PE). **Kochi Pref.:** Takaoka-gun, Hayama-mura, *H.Ohashi 660203* (TI); Kami-gun, Tosayamada-cho, Ryuga-dou, *M.Takahashi 1786* (PE). **Kyoto Pref.:** Yamashiro, Yaze, *G.Koidzumi s.n.* (TI). **Niigata Pref.:** Awajima, *K.Mori 47* (TI). **Saitama Pref.:** Aganomachi, Hanagiri, *T.Yamazaki s.n.* (TI). **Shizuoka Pref.:** Ogasa-gun, Kikugawa-cho, *S.Kurita 860808* (CBM).

This species is characterized by its reddish orange or orange-colored flowers with stamens nearly equal to or slightly shorter than tepals. But there is a cultivar (var. *alba* Hort. Mill. & Bailey, Stand. Cycl. Hort. 2:1933. 1939) with white flowers and with the leaves appear in March.

6b. Lycoris sanguinea Maxim. var. **kiusiana** (Makino) Koyama, Baileya 7:5. 1959. Ohwi, Fl. Jap. ed. 2, 384. 1978. TYPE: JAPAN. **Hizen Pref.:** Mt. Tara in Kiusiu, cultivated in Oidzumi (*T. Makino s.n.*).

Lycoris kiusiana Makino, Makinoa 9:176. 1948; Komatzuzaki, J. Jap. Bot. 32:62. 1957.

Differs from *L. sanguinea* var. *sanguinea* by the larger-sized flowers (7–9 cm long) produced in July with the tepals distinctly recurved, the longer stamens distinctly exceeding the tepals, the broader leaves (10–13 mm wide), and the earlier anthesis.

Phenology: leaves appearing in February to May; scape produced in early July to early August.

Karyotype: $2n=22A=22$ (Kurita 1988b; Takemura 1965; Yoshida 1972); $2n=33A$ & $44A$ (Kurita 1988a).

Distribution: endemic to Japan (Central Honshu and westward, mainly in Kyushu). In shady slopes under forest trees.

Specimens examined: JAPAN. **Ooita Pref.:** Mt. Kyoyomi-dake, *I.Enomoto s.n.* (TI). **Nagasaki Pref.:** Mt. Tara-dake, *H.Hara s.n.* (TI). **Tokushima Pref.:** Miyoshi-gun, Nishisofuyama-mura, Zentoku, *Y.Momiyama 288* (TI). **Wakayama Pref.:** Hitaka, Kawakami-mura, Imoo, *T.Yamasaki s.n.* (TI). **Kyoto Pref.:** Kifune, *S.Kurita 860725* (CBM). **Tokyo Pref.:** Nishitama, Mt. Kagenobu, *S.Kurita 840715* (CBM).

6c. Lycoris sanguinea Maxim. var. **koreana** (Nakai) Koyama, Baileya 7:7. 1959. TYPE: KOREA. **Prov. Zennan:** Mt. Hakuyozan, *T.Nakai 164* (HOLOTYPE: TI).

Lycoris koreana Nakai, Bot. Mag. Tokyo 44:516. 1930; Kim & Lee, Korean J. Pl. Taxon. 21:8. 1991.

This variety shows little difference in character from *L. sanguinea* var. *kiusiana*, from which it differs only by its smaller-sized perigone (5–6 cm long).

Phenology: leaves appearing in February to May; scape produced in August.

Karyotype: $2n=22A=22$ (Kurita 1988a; Tae et al. 1987; Takemura 1965).

Distribution: southern Korea and Kyushu and Tsushima Island of Japan. In moist places in the mountains; to 600 m.

Specimens examined: KOREA. Chollabuk-do, Baekyang-san, *T.Nakai 164* (TI); same locality, *S.Kurita 920815* (CBM).

7. Lycoris anhuiensis Y.Hsu & G.J.Fan, Acta Phytotax. Sin. 20:197. 1982. Hsu et al., Fl. Reipub. Pop. Sin. 16(1):25, pl.7. 1985. TYPE: CHINA. ANHUI: Langya Shan, *Y.Xu & G.J.Fan 2234* (HOLOTYPE: SHMI).

Leaves strap-shaped, ca. 35 cm long, 2–2.5 cm broad, green with a distinct whitish stripe in the center. Perigone yellow. Tepaltube 2–3.5 cm long; tepals ca. 6 cm long, 1.3–1.7 cm broad, slightly ruffle-margined, spreading and somewhat recurved. Stamens as long as tepals. Style somewhat exserted.

Phenology: leaves emerging in early spring; scape produced in August.

Karyotype: $2n=6M+10T=16$ (Hsu & Liu 1987).

Distribution: endemic to China (Jiangsu and Anhui). On stony slopes in the mountains.

Specimens Examined: CHINA. **Anhui:** Chuxian, *East China Bot. Station 3163* (PE).

This species is characterized by its yellow flowers and by its leaves possessing a whitish stripe in the center. It resembles *L. longituba* described below in both morphology and karyotype, but differs from that species in having smaller yellow flowers and shorter tepaltube.

8. Lycoris longituba Y.Hsu & G.J.Fan, Acta Phytotax. Sin. 12:299, pl.61. 1974. Hsu et al., Fl. Reipub. Pop. Sin. 16(1):27. 1985. TYPE: CHINA. Nanjing, Mt. Zijinshan, *F.X.Liu 1919* (HOLOTYPE: JSBI; ISOTYPE: SHMI). PARATYPES: Nanjing, Mt. Baohua Shan, *J.J.Gong 00869* (JSBI); Jiangning County, Mt. Dachenyishan, *M.Z.Chou 64244* (JSBI); Zhenjiang, Zhulinsi, *H.Migo s.n.* (JSBI).

8a. Lycoris longituba var. **longituba**

Leaves lanceolate, ca. 38 cm long and ca. 2.5 cm broad, with a distinct whitish stripe in the center. Perigone white with light reddish stripes or peach-colored in bud and opening pinkish. Tepaltube 4.2–6. 6 cm long; tepals 6–7 cm long, 1.5–2.1 cm broad, not ruffle-margined, somewhat recurved. Stamens slightly shorter than tepals. Style nearly equal to or slightly exceeding tepals.

Phenology: leaves appearing in early spring; scape produced in July to August.

Karyotype: $2n=6M+10T=16$ (Liu & Hsu 1989).

Distribution: endemic to China (Jiangsu and Anhui).

Specimens examined: CHINA. **Jiangsu:** Zhenjiang, *East China Bot. Station 2997* (PE); Nanjing, *F.X.Liu 1319* (PE); same locality, Sun Yat Sen Mem. Bot. Gard. cult., *Z.Z.Yu 024*, *Z.G.Mao 10501* (HZBG).

This distinctive species is characterized by its regular, large, white (or with reddish stripes) to pinkish flowers with long tepaltube (the longest in the genus). But the species shows much variation in the shape and color of flowers correlated with karyotype variation. A form with rather thick and greenish pale yellow tepals possesses $2n=7M+8T=15$; another form characterized by having shorter tepals possesses $2n=7M+6T+2A=15$. Since the short arm of this A type chromosome is revealed to be heterochromatic, it may be derived from an inversion of the T type chromosome.

8a. Lycoris longituba Y.Hsu & G.J.Fan var. **flava** Y.Hsu & X.L.Huang, Acta Phytotax. Sin. 20:198. 1982, and Fl. Reipub. Pop. Sin. 16(1):27. 1985. TYPE: CHINA. JIANGSU: Jiangning, Mt. Langshan, *Z.M.Zhou 64246* (HOLOTYPE: SHMI).

Flowers pale yellow.

Phenology: same as var. *longituba*.

Karyotype: $2n=6M+10T=16$ (Kurita et al. unpub.).

Distribution: endemic to China (Jiangsu). On slopes of hills of low elevation.

In Caldwell's (1979) reference, Fig. 11 (unidentified) No. *289* (left) undoubtedly belongs here. The plant was said to have been imported to Japan from China in the 1940s or even earlier. Caldwell got this plant from a Japanese hobby gardener, Dr. Shuichi Hirao of Kanagawa.

9. Lycoris caldwellii Traub, Pl. Life 13:46, pl.4. 1957. Caldwell, Pl. Life 13:55. 1957; Hsu et al., Fl. Reipub. Pop. Sin. 16(1):24. 1985. TYPE: UNITED STATES. TENNESSEE: Nashville (cult.), *S.Caldwell 552* (HOLOTYPE: TRA); same locality, *S.Caldwell 222* (PARATYPE: TRA). According to Caldwell's remark, the type material was probably taken to the United States from a shipment out of Shanghai, China, before 1949.

Leaves without a whitish stripe in the center. Flowers between the spiderlily-form and funnel-form, in bud peach-colored, opening to pale yellow, changing gradually to creamy white with age. Tepaltube 2–2.2 cm long; tepals oblanceolate, 7–7.5 cm long, slightly undulate margined, recurved, 1.2–1.4 cm broad. Stamens shorter than tepals. Style subequalling tepals.

Phenology: leaves appearing in early spring; scape produced in late August to September.

Karyotype: $2n=6M+10T+11A=27$ (Bose 1957; Liu & Hsu 1989).

Distribution: endemic to southeastern China (Jiangsu, Zhejiang and Jiangxi).

Specimens examined: CHINA. **Zhejiang:** Hangzhou, Hangzhou Bot. Gard. cult., *J.Z. Lin 011* (HZBG).

The leaves of this species lack a whitish stripe or band in the center, which is a distinctive feature of all the species of Subgen. *Lycoris*. Although the karyotype

of this species is consistent with that of *L. squamigera*, the gross morphology is quite different from that species.

10. **Lycoris shaanxiensis** Y.Hsu & Z.B.Hu, Acta Phytotax. Sin. 20:196. 1982. Hsu et al., Fl. Reipub. Pop. Sin. 16(1):24. 1985. TYPE: CHINA. Shaanxi, Mt. Qingling, Nanwutaishan, *Z.B.Hu & S.C.Feng 3566* (HOLOTYPE: SHMI). But M.X.Qian of SHMI told the present authors that the type specimens of both *L. shaanxiensis* and *L. guanxiensis* were not in their herbarium.

Leaves strap-shaped, ca. 50 cm long and 0.8 cm broad, without a distinct whitish stripe in the center. Perigone white, with a few pinkish stripes inside and a reddish keel underside of each tepal. Tepaltube ca. 2 cm long; tepals slight ruffled–margined, recurved. Stamens shorter than tepals. Style somewhat exserted.

Phenology: leaves appearing in early spring; scape produced in August to September.

Karyotype: no reports.

Distribution: endemic to China (Shaanxi).

11. **Lycoris guangxiensis** Y.Hsu & G.J.Fan, Acta Phytotax. Sin. 20:196. 1982. Hsu et al., Fl. Reipub. Pop. Sin. 16(1):22, pl.6, fig. 1–2. 1985. TYPE: CHINA. Guangxi, Duan, *Y.Xu. & G.J.Fan s.n.* (HOLOTYPE: SHMI). The type specimen has not been found in SHMI.

Leaves narrow strap-shaped, 24–29 cm long, 1–1.2 cm broad, dark green with a distinct whitish stripe in the center. Perigone yellow, with reddish bands. Tepaltube 1.5–2 cm long; tepals obovate-oblanceolate to oblanceolate, ca. 7 cm long and 1.5 cm broad, narrowing to a claw at base, slightly ruffled-margined, recurved. Stamens subequalling tepals. Style exserted.

Phenology: leaves emerging in early spring; scape produced in July to August.

Karyotype: no reports.

Distribution: endemic to China (Guangxi).

No specimens of this species are available to the present authors. According to the type description, this species is most closely related to *L. chinensis* Traub but differs from that species in its perigone having reddish bands inside, and in its narrower, dark green leaves.

12. **Lycoris chinensis** Traub, Pl. Life 14:44. 1958. Hsu et al., Fl. Reipub. Pop. Sin. 16(1):22, pl.5, fig. 4. 1985; M.Kim & S.Lee, Korean. J. Pl. Taxon. 21:126, fig. 5–6. 1987. TYPE: UNITED STATES. CALIFORNIA: La Jolla, cultivated, *H.P.Traub 585* (HOLOTYPE: TRA). According to Traub's remark, the type plant was grown from a bulb (*P.I.162443*) furnished by J.L.Creech originally obtained from Sun Yat Sen Memorial Garden in Nanjing, China, in 1948.

Leaves strap-shaped, round at the apex, ca. 35 cm long, ca. 2 cm broad, green with a distinct whitish stripe in the center. Perigone chrome yellow, with a

yellowish midrib underside of each tepal. Tepaltube 1.5–2.5 cm long; tepals oblanceolate, 5.5–7.7 cm long, 7–13 mm broad, distinctly crisped-margined and strongly recurved. Stamens subequalling or somewhat exceeding tepals, filament yellowish. Style rose-colored in the upper part.

Phenology: leaves appearing in early spring; scape produced in late July to August. Fruits in September.

Karyotype: $2n=6M+10T=16$ (Bose 1960; Chen & Li 1985; Liu & Hsu 1989).

Distribution: China (Henan, Shaanxi, Sichuan, Zhejiang, and Jiangsu) and southern Korea. On moist slopes in the mountains; ca. 750 m.

Specimens examined: CHINA. **Jiangsu:** Jurong, Baohua Shan, *Jiangsu Natural Pl. Sources Exped. 5426* (HZBG); Yixing, *Y.L.Keng 2562* (PE). **Sichuan:** way from Daheba to Sanquan, *J.H.Xiong & Z.L.Zhou 92976* (SZ). **Zhejiang:** Ningbo, *Y.L.Keng 1117* (FUS); Tianmu Shan, *Y.Y.Ho 24601, 24687, 25259, 29332,* (HZBG); Hangzhou, *S.Y.Chang 858, 1327* (HZBG); same locality, *Hangzhou Bot. Gard.*, cult., *Z.Z.Yu 003, 006, 007, 011, 015, 017* (HZBG).

This species resembles *L. aurea* and *L. traubii* in general appearance, but differs remarkably from them in its foliage appearing in early spring instead of in autumn and winter, in the flowers having a chrome yellow color, and in the stamens subequalling or slightly surpassing the tepals. Both *L. aurea* and *L. traubii* bloom in September to October, later than that of *L. chinensis*.

The Korean plants, which Tae et al. (1987) have mistaken to be "*L. aurea*," are morphologically very similar to typical *L. chinensis*, and the chromosome number is also $2n=16$, but the karyotype is slightly different ($2n=6M+2SM+8T$). These SM type chromosome may have originated from an inversion of a T type chromosome. So the Korean taxon may be derived from the typical Chinese *L. chinensis*. Bose (1966) also reported a SM type chromosome of the same sort in a bulb of *L. chinensis*, but he did not mention the source of material that he examined. A cultivated form called "*L. sperryi*" has also $2n=6M+10T=16$.

13. **Lycoris aurea** (L'Hér.) Herb., Bot. Mag. 47:t.2113. 1821. Hance, J. Bot. 12:262. 1874; Franch. & Sav., Enum. Pl. Jap. 2:44. 1879; Maxim., Bot. Jahrb. 6:79. 1885; Baker, Handb. Amaryll. 40. 1888; Forest, Gard. Chron. Ser.3, 47:12, fig. 15. 1910; Diels, Notes Bot. Gard. Edinburgh 6:192. 1912; Hayward, Pl. Life 13:41. 1957; Koyama, Baileya 7:5. 1959; Icon. Cormophyt. Sin. 5:549, fig. 7928. 1976; Hsu et al., Fl. Reipub. Pop. Sin. 16(1):20, pl.5, fig. 1–3. 1985. Type: not cited. According to Alton's (1811) reference, this species was introduced to England from China by J. Fothergill in 1777.

Amaryllis aurea L'Hér., Sert. Angl. 14, pl.15. 1788, with descriptions in Hort. Kew 1:419. 1789; Bot. Mag. 12:t.409. 1798.

13a. Lycoris aurea var. aurea

Leaves ensiform, acutish at the apex, up to 76 cm long and to 2.5 cm broad, dull green, glaucous, with a conspicuous whitish stripe in the center. Scape up to 76 cm long. Spathe-valves lanceolate, 7–8 cm long. Pedicel 15–22 mm long.

Flowers somewhat upright. Perigone cadmium yellow, with a pale green stripe underside of each tepal. Tepaltube 1.2–1.5 cm long, straight; tepals narrowly elliptic, 5–6 cm 1ong, 7–12 mm broad, decidedly crisped-margined, strongly recurved. Stamens yellowish, surpassing tepals about 1/6–1/3. Style exserted, reddish in the upper part.

Phenology: leaves appearing in autumn in flowering time; scape produced in August to September, before leaves.

Karyotype: $2n=10M+2T=12$ (Bose 1958); $2n=9M+4T=13$ (Bose & Flory 1963, Inariyama 1937); $2n=8M+6T=14$ (Liu & Hsu 1989); $2n=7M+8T=15$ (Bose & Flory 1963); $2n=7M+1A+7T=15$ (Kurita 1987a); $2n=6M+10T=16$ (Liu & Hsu 1989).

Distribution: to China and Indochina; in China in southern Henan, Shaanxi, and Gansu, southern Jiangsu, Zhejiang, Jiangxi, Guangdong, Guangxi, Hunan, western Hubei, Sichuan, Guizhou, and Yunnan. Usually in sheltered moist rocky or grassy slopes along streams and at the edges of forests in the mountains; (110)500–2250 m.

Specimens examined: CHINA. **Gansu:** Wenxian, *Q.X.Li & X.C.Zhao 2420* (PE): Kangxian, *Z.Y.Zhang 16484* (PE). **Guangdong:** Guangzhou, cult. *Y.Tsiang 13268* (PE); Hongkong, Kadoorie farm, brought by Gloria Barretto, *S.Y.Hu 11050* (PE). **Guangxi:** no locality, *Guangxi Pl. Exped. 4034* (PE). **Guizhou:** Huaxi, cult. *Z.Y.Cao 2480* (PE); Jiangkou, southeast side of Mt. Fanjing Shan, *Sino-American Guizhou Bot. Exped. 217* (PE); Xingyi, *Z.S.Zhang & Y.T.Zhang 6516* (PE); Bijie, Baohuixiang, *P.H.Yu 321* (PE); near Panxian, *Anshun Exped. 1298* (PE); Yinjiang, *C.B.Jian 30598* (PE). **Henan:** Jigong Shan, *Forest. Depart. Henan Prov. 353* (PE); Tongyang, *X.Q.Zhang 20211* (PE). **Hubei:** Badong, Shennongjia, *G.X.Fu & Z.X.Zhang 1170* (PE); Fangxian, *C.L.Cheng 538* (FUS); *K.M.Liou 9065, 9092, 9123* (PE); Enshi, *L.Y.Dai & Z.H.Qian 620* (PE). **Hunan:** Yongshan, *L.H.Lui 9475* (PE); Anjiang, *Agri. School 1466* (PE); Nanyue, *Y.Liu 376* (PE); Qiangang, Xuefeng Shan, *Z.T.Li 2721* (PE). **Jiangsu:** Yixing, *W.Z.Fang et al. 248* (SZ). **Zhejiang**: Tianmu Shan, *Y.Y.Ho 25259* (PE); *T.Tang & W.Y.Hsia 500* (PE); *Zhejiang Pl. Sources Exped. 29332* (PE); Hangzhou, *S.Y.Chang 1327* (PE); Hangzhou Bot. Gard., cult. *Z.Z.Yu 009* (HZBG); no locality, *R.C.Ching 5256* (FUS); *5349* (PE). **Sichuan:** Wuxi, *K.L.Chu 1924* (PE); no locality, *T.Tang 23625* (PE); Wanyuan, *P.Y.Li 5584* (PE); Wenchuan, *S.Y.Chen et al. 5896* (SZ); Yaan, *Yaan Exped. 1125* (CDBI); Jieshan, *Jieshan Exped. 78-0751* (CDBI); Jiangjin, *Jiangjin Exped. 519* (CDBI); Huidong, *Huidong Exped. 341* (CDBI); Huili, *Taiping Exped. 414* (CDBI); Fengdu, *Fengdu Exped. 744* (CDBI); Youyang, *Youyang Exped. 506* (CDBI); Wulong, *Wulong Exped. 1302* (CDBI); Pengshui, *Pengshui Exped. 1185* (CDBI); Xiushan, *Xiushan Exped. 1177* (CDBI); Leibo, *Leibo Med. Exped. 967* (CDBI); Xuanhan, *Xuanhan Exped. 1175* (CDBI); Tongjiang, *Tongjiang Exped. 756* (CDBI); Lingshui, *Lingshui Exped. 965* (CDBI); Guanxian, Qingchen Shan, *Z.L.Wu 33955* (PE); Bushi, *Sichuan Econ. Pl. Exped. 5803* (PE); way from Daheba to Yuquan, *J.H.Xiong & Z.L.Zhou 92976* (PE); Chengkou, *T.L.Dai 102283* (PE); Jiange, *T.N.Liou & C.Wang 293* (PE); Mt. Emei, *T.Y.Chow & G.J.Xu 586* (PE); Hechuan, Huaging Shan, *T.H.Tu 5202* (PE); Huidong, *Q.S.Zhao 5799* (SZ); *H.N.Wang 79626* (FUS); without precise locality, *F.T.Wang 22305* (PE); Ebian, *C.W.Yao 3016* (PE). **Shaanxi:** Ziyang, near Liangshuang River, *P.Y.Li 6382* (PE); Taiba Shan, *T.S.Chen 3684* (FUS). **Yunnan:** Jianchuan, Mekong Divide, *G.Forrest 23567* (PE); Gongshan, *T.T.Yu 23023* (PE); Kunming, *T.N.Liou 16381* (PE); Shuangbai, *H.T.Tsai 54346, 54601* (KUN, PE, SZ); Qiujiang Valley, *T.T.Yu 19912* (PE); Jianchuan, *R.C.Ching 23103* (PE); Lunan, *B.Y.Qiu 55917* (PE); Yiliang, *Northeast Yunnan*

Exped. 944 (PE); Gongshan, *Qinghai-Xizang Exped. 9557* (PE); Jianchuan, *R.C.Ching 23103* (KUN); Qiubei, *Kunming Bot. Inst. 61–3777* (KUN); Anning, *C.Y.Wu 231* (KUN); Yiwu, *S.J.Pei 59-10108* (KUN).

Redouté (1822), followed later by Kunth (1850) and Traub and Moldenke (1949), treated *Amaryllis africana* Lam. (=*Lycoris africana* (Lam.), M.J.Roem.) as a synonym of *A. aurea* L'Hér. (=*L. aurea* (L'Hér.) Herb.). Recently, some authors (e.g., Bailey & Bailey 1976; Everett 1983) have adopted *Lycoris africana* (Lam.) M.J.Roem. as the valid name over *L. aurea* on the basis of the fact that *A. africana* Lam. (1783) antedates *A. aurea* L'Hér. (1788). But it should be noted that according to Lamarck's (1783) original description, *A. africana* was cultivated in a garden in Roi and was said to have been introduced from Africa and Madagascar, out of the range as so far known of *L. aurea*. From a morphological point of view, these two names may refer to the same entity. But we are not making the substitution at the present time pending further studies on type material of the taxa involved.

This subtropical species has a relatively wide distribution extending into southeastern Asia, China and Indochina. It is characterized by its long and broad ensiform leaves almost acute at the apex, its cadmium yellow flowers with strongly crisped and recurved tepals, and its moderately exserted stamens. But some of the collections from Sichuan (*F.T.Wang 22305* and *C.W.Yao 3016*) have long exserted stamens.

Five cytoraces ($2n=12, 13, 14, 15, 16$) under the name of *L. aurea* have been reported by various authors (Bose 1958; Bose and Flory 1963; Inariyama 1931, 1932, 1937; Kurita 1987a; Liu & Hsu 1989). But as a result of a reexamination of these cytoraces by Kurita (unpub.), only three of them have been confirmed: $2n=14=8M+6T$, $2n=15=7M+8T$, and $2n=16=6M+10T$. These cytoraces are morphologically distinguishable from one another. The $2n=15$ cytorace has ascending tepals and very narrow leaves acute at the apex. The description of *L. aurea* var. *surgens* Worsley ex Traub & Moldenke as well as the figures of *L. africana* (Lam.) M.J.Roem. published in *Encyclopedia of Horticulture* of New York Botanical Garden (Everett 1983) match well with this cytorace. Kurita (1987a) suggested that this highly sterile cytorace might have originated either from the cytorace having $2n=16$ through centromeric fusion between two T type chromosomes, or might have been produced by crossing between two fertile cytoraces or species having $2n=14$ and $2n=16$. In the $2n=16$ cytorace, the leaves are pendulous and are the largest among all cytoraces (60–80 cm long and 4–6 cm broad) with a blunt apex. This cytorace may be a rheophyte adapted to riverside habitats. The size and shape of leaves of the $2n=14$ cytorace are in the middle of the above two cytoraces, but the midrib on the under surface of leaves is reddish purple, and the central part of each tepal is greenish. Kurita (unpub.) suggested that these cytoraces might not be the simple products of Robertsonian changes of a single species.

For a long time, taxonomists have confused this species with *L. traubii* Hayward, which occurs only in Taiwan and southern Japan (Kurita 1980). Many specimens identified to be "*L. aurea*" in Japanese herbaria belong to *L. traubii*. Hayward (1957) and Kurita (1980) made morphological comparisons of these two species. Kurita et al. (unpub.) recently added that the remains of leaf-bases is prominent at the base of scapes of *L. aurea*, whereas in *L. traubii* there is no such residue.

13b. **Lycoris aurea** (L'Hér.) Herb. var. **surgens** Worsley ex Traub & Moldenke, Amaryllidac.: Amaryll. 180. 1949. TYPE: UPPER BURMA: cultivated at the Royal Hortiucltural Society of England, *Clapham Jukes*, Oct 1904 (Worsley 1928).

All of the tepals ascending.

Karyotype: no reports.

Distribution: Upper Burma.

No specimens of this variety are available to the present authors. Worsley (1928) and Traub and Moldenke (1949) remarked that the foliage is distinct, but they gave no further descriptions. This variety is probably in accord with the cytorace of *L. aurea* having $2n=15$.

13c. **Lycoris aurea** (L'Her.) Herb. var. **angustitepala** Hsu, Kurita, Yu, & Lin, var. nov.

A varietate *aurea* tepalis angustioribus 4–8 mm latis, staminibus longioribus tepalum 1/3–1/2 superantibus differt.

This variety differs from var. *aurea* mainly in having narrower tepals and long-exserted stamens.

TYPE: CHINA. HUBEI: Fengxian, Guanyindong, 88 m, in rock crevices, flowers pale yellow, rare, *K.M.Liou 9230*, 17 Aug 1938 (HOLOTYPE: PE).

Specimens examined: CHINA. **Gansu:** Kangxian, on way from Yangba to Xiaoheba, in rock crevices by a river, alt. 1000 m, scape 0.5 m high, purplish at the base, flowers yellow with black anthers, frequent, 9 Aug 1963, *Z.Y.Zhang 16484* (PE).

14. **Lycoris traubii** Hayward, Pl. Life 13:40. 1957. Traub, Pl. Life 13:44. 1957, and 14:43. 1958, in clavis; Ohwi, Fl. Jap. ed. 2, 384. 1978. TYPE: UNITED STATES. CALIFORNIA: La Jolla, cult., *Hamilton P. Traub 558a* (HOLOTYPE: MO). There is a note on the type specimen that the bulbs of this plant were imported from Japan in 1952 by Sam W. Sayler, Fernandina Beach, Florida.

Lycoris aurea auct. non (L'Hér.) Herb.: Masam. & Hayata, J. Coll. Sci. Univ. Tokyo 22:431. 1906; C.F.Hsieh, Fl. Taiwan 5:94, pl.1289, sub 93. 1978.

Leaves lorate-lanceolate, to ca. 22.5 cm long, 1.2–2.1 cm broad, obtuse at apex, glabrous, not glaucous, with a distinct whitish stripe in the center. Scape to 50 cm long. Spathe-valves ovate, 3–5 cm long. Pedicels 8–9 mm long. Flowers more or less horizontally spreading. Perigone rich orange-yellow, with a

deeper band in the center. Tepaltube 1.5–2 cm long, recurved downwards; tepals narrowly oblanceolate, 6.8–7 cm long, 1.3–1.6 cm broad, strongly recurved. Stamens slightly exserted. Style longer than stamens, reddish only on tip.

Phenology: leaves appearing in autumn, about a month later than in *L. aurea;* scape produced in early September to October.

Karyotype: $2n=10M+2T=12$ (Bose 1958; Bose & Flory 1963; Kurita 1987b); $2n=9M+4T=13$ (Bose 1958; Bose & Flory 1963; Kurita 1987b); $2n=8M+6T=14$ (Kurita 1987b).

Distribution: Taiwan and southernmost Japan, including southern Kiushu and Loochoo Islands. On slopes where moisture is sufficient and at edges of forests; to 100 m.

Specimens examined: JAPAN. **Kagoshima Pref.:** Ibusuki, *S. Kurita 891015* (CBM). **Okinawa Pref.:** Yonagunijima Isl., west of Sonai, *K.Schimabukuro & Y.Miyagi 5198* (TI); Okinawa Isl., Kuganiimu, *S.Kurita 931020* (CBM).

CHINA. **Taiwan:** Keelung, *S.Inariyama s.n.* (TI).

Kurita (1987b) detected two cytoraces having $2n=12$ and 14 respectively with distinguishable morphological characteristics. The leaves of the race with $2n=12$ are somewhat dark blue-green and the tepals are strongly recurved; in the race having $2n=14$ the leaves are lustrous yellow-green and the tepals are moderately recurved. Based on C-banding pattern, Kurita (1987b) suggested that the sterile cytorace having $2n=13$ may be a hybrid between the two fertile cytoraces having even chromosome numbers.

15. **Lycoris ×albiflora** Koidz. (pro sp.), Bot. Mag. Tokyo 38:100. 1924. Makino, Acta Phytotax. Geobot. 13:18, pl.2. 1943; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 178. 1949; Koyama, Baileya 7:4. 1959; Traub, Pl. Life 22:59. 1966; Ohwi, Fl. Jap. ed. 2, 384. 1978; Hsu et al., Fl. Reipub. Pop. Sin. 16(1):22. 1985. Type: Not indicated. Koidzumi remarked that this species was cultivated in Japan and was perhaps spontaneous in the Amamiohshima Island of that country.

Leaves up to 35 cm long, 1.2–1.5 cm broad, somewhat yellowish green with a rather inconspicuous whitish stripe in the center. Flowers pink in bud, opening creamy white, changing to white with age, with a very light orange-yellow stripe in the center of each tepal. Tepaltube ca. 2 cm long; tepals 6.5–7.5 cm long, 1–2.2 cm broad, moderately ruffled-margined, strongly recurved. Stamens long, far exceeding tepals. Style slightly exserted.

Phenology: leaves emerging in autumn; scape produced in mid September to early October.

Karyotype: $2n=5M+1T+11A=17$ (Bose 1960; Kurita 1987a); $2n=5M+1T+11A+1m=18$ (Kurita 1987a).

Distribution: southwestern Japan, mainly in Kyushu. In moist places by streams and hillsides, and disturbed places near human habitation and in graveyards; 30–500 m. Also cultivated as an ornamental in Japan.

Specimens examined: JAPAN. **Kagoshima Pref.**: Kaseda, Tojinbaru, *H.Ohba & S.Akiyama 2627* (TI). **Kumamoto Pref.**: Amakusa, Kawaura, *M.Yamada 2645* (CBM). **Okinawa Pref.**: Iejima Island, *M.Tashiro s.n.* (TI). **Shizuoka Pref.**: Odawara, cult., *S.Kurita s.n.* (CBM).

This species is characterized by the creamy white flowers with long exserted stamens. It is somewhat comparable to *L. radiata*, but that species possesses crimson flowers with narrower tepals and narrower leaves, and leaves with a distinct whitish band in the center.

The karyotype of *L. ×albiflora* is very variable. Besides $2n=17$ & 18, complements possessing $2n=16$ (Inariyama 1931) and 19 (3M+5T+11A) have been found in Japan and China. The cytotype having $2n=19$ has been attributed to "*L.* aff. *albiflora* Koidz." by Lin & Hsu (1989) and to "*L. ×elegans*" by Lin et al. (1990). *L. ×elegans* Liu & Hsu, ined. resembles *L.* aff. *straminea* Lindl. (Lin et al. 1990, Xu et al. 1986,) or "*L. straminea*" (Liu & Xu 1990) very much in gross morphology as well as in karyotype. This has caused much difficulty in identification.

The origin of this highly sterile species with $2n=17$ or 18 is problematical. Inariyama (1932, 1933, 1937) once considered it to be a hybrid between *L. traubii* (mistaken to be *L. aurea*) and *L. sanguinea* in the light of cytological point of view. Based on gross morphology, Makino (1943) supposed it to be a hybrid between *L. radiata* and *L. aurea*. Inariyama (1944), however, had changed his opinion and advocated strongly that the species originated from hybridization between *L. traubii* and *L. radiata* var. *pumila*. This was supported by Takemura (1962a), and especially by Caldwell (1981), who made crossing tests between the said species and as a result brought forth hybrids that were very similar to or almost exactly like *L. ×albiflora* in gross morphology. But since *L. radiata* var. *pumila* does not occur in Japan, Kurita (1987a) suggested that the putative parents of *L. ×albiflora* (5M+1T+11A) were *L. radiata* (11A) and *L. traubii* (5M+1T). He argued that despite being a triploid sterile plant, *L. radiata* produces some viable pollen occasionally (Koyama 1959). Moreover, the flowering period of the two species overlaps at times. The m type chromosome in the complement of $2n=18$ might come from a race of *L. radiata* possessing such a chromosome together with the other 11 A type chromosomes.

The origination of the cytotype $2n=3M+5T+11A=19$ of *L. ×albiflora* is interesting. This cytotype in China probably occurs only in cultivation. It has broader and less wrinkled tepals and shorter stamens. According to Kurita's (1987a) suggestion, it is a hybrid between two diploid species, one with $2n=16$, which produces gametes having 3M+5T, and the other with $2n=22A$, which gives rise to genomes consisting of 11A. Based upon crossing tests, Lin et al. (1990) proved that both *L.* aff. *albiflora* ($2n=19$) and *L.* aff. *straminea* are segregates in the F_1 progeny of the *L. haywardii* × *L. chinensis* combination.

16. **Lycoris ×houdyshelii** Traub (pro sp.), Pl. Life 13:45, pl.3. 1957. Hsu et al., Fl. Reipub. Pop. Sin. 16(1):20. 1985. TYPE: UNITED STATES. TENNESSEE: Nashville

(cult.), *S.Caldwell 549* (HOLOTYPE: TRA); same locality, *S.Caldwell 550, 551* (PARATYPE: TRA). Traub remarked that the type material was imported from a Chinese nurseryman in Shanghai, China, in 1948.

Leaves strap-shaped, 30–42 cm long, 1–1.3 cm broad, rounded at the apex, deep green with a slightly distinct whitish midrib. Perigone creamy white, turning whitish with age, sometimes with reddish lines running along tepals or may develop a rose flush, with a greenish midrib underside. Tepaltube 8.5–12 mm long; tepals linear-oblanceolate, up to 5 cm long, 8–10 mm broad, slightly ruffled-margined, recurved. Stamens exceeding tepals ca. 1/3, filaments creamy white, sometimes tinged with pink. Style exceeding the stamens, pink tipped.

Phenology: leaves appearing in autumn, persisting to spring; scape produced in late July to August.

Karyotype: $2n=3M+6T+21A=30$ (Bose 1957); $2n=3M+5T+22A=30$ (Kurita 1987a).

Distribution: endemic to China (Zhejiang, known only in cultivation).

Specimens examined: CHINA. **Zhejiang:** Hangzhou, Hangzhou Bot. Gard., cult., *Z.Z.Yu 008* (HZBG).

A specimen in PE collected in a garden called "Caojiahuayuan" in Shanghai without notes of collector and field number also belongs here.

Kurita (1987a) suggested that this sterile species is a triploid hybrid between *L. longituba*, which produced the gamete having 3M+5T, and another species with an unreduced 22A, which was one of the following: *L. radiata* var. *pumila*, *L. rosea*, *L. ×haywardii,* or *L. sprengeri*.

17. **Lycoris straminea** Lindl., J. Hort. Soc. London. 3:76. 1848, nomen subnud., and emend. Traub, Pl. Life 12:42. 1956; Walp., Ann. Bot. Syst. 1:834. 1848–49; Kunth, Enum. Pl. 5:546. 1850; Baker, Handb. Amaryll. 40. 1888; Spreng., Bull. Soc. Tosc. Ortic. 8:326. 1888; Worsley, Gard. Chron. ser. 3, 84:169. 1928; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 178. 1949; Traub, Pl. Life 13:43. 1957, in clavis; Hsu et al., Fl. Reipub. Pop. Sin. 16(1):18, pl.4, fig. 4. 1985. TYPE: CHINA. *Robert Fortune 148* (HOLOTYPE: MO). According to Traub (1956), this species was sent to the Kew Botanical Gardens by Robert Fortune from China in 1845. The first author of the present paper, however, has been able to examine the type specimen of this species at the herbarium of Missouri Botanical Garden. The sheet (MO herb. no. 3149486) actually consisted of two different specimens. Traub's emendation description of *L. straminea* was based on the left hand one, while the right hand one was much slenderer in shape with narrower tepals (ca. 4 mm wide) and longer tepaltube (5.3–5.5 mm).

Leaves strap-shaped, 24–49 cm long, 1.3–2 cm broad, obtuse at the apex, green with an inconspicuous whitish band in the center. Scape up to 22.1 cm long. Perigone with tepals pale straw-colored, with a pink band and a few scattered red dots on the upper surface, changing to white in full blossom. Tepaltube 4–5.5 mm long; tepals linear-oblong, 3.5–4.1 cm long, 5.2–12 mm broad, undulate margined and strongly recurved. Stamens exceeding tepals ca. 1/3. Style long exserted.

Phenology: leaves appearing in autumn; scape produced in August.

Karyotype: no reports.

Distribution: endemic to China (Jiangsu and Zhejiang). In shady places in sparse woods; ca. 100 m.

Specimens examined: CHINA. **Jiangsu:** Nanjing, *Z.P.Wu s.n.* (JSBI). **Zhejiang:** Hangzhou, Feilaifeng, *H.Q.Zhu 859 & 1328* (HZBG); same locality, Hangzhou Bot. Gard., cult., *J.Z.Lin 001* (HZBG). **No locality:** *Z.B.Wang 11602* (PE).

This species seems somewhat like *L.* ×*albiflora*, but differs from that species in that the foliage appears in autumn, as well as by its smaller, pale-straw-colored flowers with pink stripes and red dots, and by its shorter tepaltube.

This species may also be of hybrid origin, and the type specimens were probably from segregates of the F_1 progeny of *L. radiata* var. *pumila* and a species with $2n=16$ combination. Lin et al. (1990) brought forth a hybrid between *L.* ×*haywardii* ♀ and *L. chinensis* ♂, and they have named the hybrid *L.* aff. *straminea*. It matches typical *L. straminea* in many respects in gross morphology and possesses $2n=3M+11T+5A=19$. Their investigation has shown that as much as 81.9% of the pollen of this sterile hybrid is shriveled. Besides, this hybrid not only failed to set seed under natural conditions, but failed to do so even under conditions of artificial pollination.

18. Lycoris elsiae Traub, Pl. Life 14:43. 1958. TYPE: UNITED STATES. TENNESSEE: Nashville, cult., *S.Caldwell 593* (HOLOTYPE: TRA); same locality, *S.Caldwell 594* (PARATYPE: TRA). Traub remarked that the type material was sent to the United States from Japan. There are two specimens (*W.H.Preston,Jr. 964, 965*) in MO (Herb. nos. *628, 629*) transferred from Traub Herbarium of the American Plant Life Society under the name of *L. elsiae* Traub collected from Japan. Both specimens have flowers "white, slightly yellow-pink-tinged," and are not in accord with the type description of the species.

Leaves linear, 32–36.5 cm long, 1.2–1.3 cm broad, rounded at the apex, dark green. Scape 30–70 cm long. Perigone soft salmon-colored, finally fading to a flesh color, with a deep pinkish band tinged with creamy and yellow along the center of each tepal. Tepaltube 1.2–1.3 cm long; tepals oblanceolate, ca. 4 cm long, up to 7 mm broad. Stamens exceeding the perigone. Style longer than stamens.

Phenology: leaves appearing in autumn; scape produced in August to early September.

Karyotype: $2n=17$ (Bose 1960; Bose & Flory 1963).

Distribution: endemic to Japan.

The identity of this Japanese species is not yet clear. It has scarcely been included in any published Japanese floras. It is morphologically somewhat comparable to *L.* ×*houdyshelii*, but differs from that species in flower color and a longer tepaltube. It may be a hybrid between *L. traubii* and *L. sanguinea* var. *kiusiana*, both of which occur in the southern part of Kyushu.

19. Lycoris radiata (L'Hér.) Herb., Bot. Mag. 47:t.2113. 1821. Bot. Reg. 4, Append. 20, pl.596. 1821; Hance, J. Bot. 12:262. 1874; Franch. & Sav., Enum. Pl. Jap. 2:44. 1878; Maxim., Bot. Jahrb. 6:78. 1885; Baker, Handb. Amaryll. 40. 1888; Spreng., Bull. Soc. Tosc. Ortic. 8:326. 1888; Bretschneider, Hist. Eur. Bot. Disc. China 1:509. 1898; Yashiroda, Gard. Chron. ser. 3, 38:9, fig. 4. 1930; Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 177. 1949; Koyama, Baileya 7:2. 1959; Icon. Cormophyt. Sin. 5:549, fig. 792. 1976; Ohwi, Fl. Jap. ed.2, 384. 1978; M.Kim & S.Lee, Korean. J. Pl. Taxon. 21:11. 1991.

Amaryllis radiata L'Hér., Sert. Angl. 15. 1788.
Nerine japonica Miq., Ann. Mus. Bot. Lagduno-Batavum. 2:139. 1865–66.
Lycoris terraccianii Dammann, Cat.44:4. 1889.
Lycoris radiata (L'Hér.) Herb. var. *terraccianii* Dammann, l.c.

19a. Lycoris radiata var. **radiata** TYPE: not indicated. Baker (1988) remarked that this species was observed by Kaempfer as early as 1712 and was introduced to English gardens in 1750. The type material was most probably from China.

Leaves narrow strap-shaped, up to 50 cm long, 3–8 mm broad, obtuse at apex, deep green with a whitish stripe in the center. Scape 30–60 cm long. Perigone bright red. Tepaltube 5–8 mm long; tepals narrow oblanceolate, 4–4.5 cm long, 5–6 mm broad, strongly crisped-margined and recurved. Stamens 2–2.5 times the length of tepals. Style long exserted.

Phenology: leaves appear in autumn and wither in April; scape produced in late September to early October.

Karyotype: $2n=33A=33$ (Bose 1959; Bose & Flory 1963; Fukuda et al. 1980; Inariyama 1931, 1933, 1937, 1951; Koyama 1962; Kurita 1987c; Liu & Hsu 1989; Nishikawa et al. 1979; Nishiyama 1928); $2n=1M+31A+1m=33$ (Bose 1963; Kurita 1987c); $2n=31A+1M'=32$ (Kurita 1987c).

Distribution: Japan (Aomori and southwestward), Korea, China, and Nepal. In moist, often disturbed places such as edges of paddy fields, margins of plantations, waste places around dwellings, and graveyards; to 800 m in Japan. Extensively naturalized in southeastern United States.

Specimens examined: CHINA. **Anhui:** Chuxian, Langya Shan, *Z.Z.Ding & J.S.Yue 0681* (PE); Jinzhai, *S.X.Shen 1101* (ACE); Huang Shan, *L.G.Fu 520* (JSBI); *R.C.Ching s.n.* (NJU); Shucheng, *East China Bot.Station 4620* (JSBI); Jixi, *X.L.Liu 057* (PE). **Fujian:** Shanghang, *L.G.Lin 6960* (PE); *Amoy Univ. Fujian Exped. 1195* (PE); Nanjing, *Amoy Univ. Fujian Exped. 64564* (FUS); Ninghua, *Fudan Univ. Fujian Exped. 91974* (FUS); Shaxian, *Fudan Univ. Fujian Exped. 53473* (FUS); no locality, *Y.Ling 2585* (PE); Shucheng, *East China Bot. Stat. 4620* (PE). **Guangdong:** Liannan, *P.X.Tan 59386* (PE); Xinfeng, *L.Deng 8147* (PE). **Guangxi:** no locality, *Inst. Bot. Guangxi Exped. 3965* (PE). **Guizhou:** Jiangkou, Xuefeng Shan, on the south side of Mt. Fanjing Shan, *Sino-American Guizhou Bot. Exped. 844* (PE); same locality, Daiyenfeng along the Kaitu River on the southwest side of Mt. Fanjing Shan, *Sino-American Guizhou Bot. Exped. 1133* (PE); Xishui, *Bijie Exped. 1577, 1712* (PE); Hexian, *Anshun Exped. 1299* (PE). **Hubei:** Lichuan, *R.Y.Dai & Z.H.Qian 920* (PE); *G.X.Fu & Z.S.Zhang 1745* (PE); Qianshih, *C.C.Ho s.n.* (PE); Xuanan, *H.J.Li 4662* (PE); Fangxian, *K.M.Liou 8972, 9231* (PE); *C.L.Cheng 509* (FUS); *G.B.Hu 537* (FUS); no locality, P.Y.Li *5052* (PE); Zhuxi, *P.Y.Li 9504* (SZ). **Hunan:** Baojing,

L.H.Liu 9762 (PE); Yizhang, *S.Q.Chen 1987* (PE, SZ). **Jiangsu:** Nanjing, *K.L.Chu 318* (PE); *W.Z.Fang* et al. *352* (SZ); *Z.R.Wang 80* (FUS); *X.C.Sun 5* (PE); Jiangning, *J.S.Yue 0561* (PE); Yixing, *W.Z.Fang 196* (PE); Shanghai, Jiangwan, *T.N.Yan 10412* (FUS). **Jiangxi:** Shangrao, *S.S.Lai & M.X.Nie 4750* (FUS, PE); Lushan, *H.C.Cheo 98* (NJU); *F.T.Wang s.n.* (PE); *K.C.Kuan 74250* (PE); *H.H.Hu 2212* (PE); Nanchang, *S.H.Hsiung 666* (PE); Anju, Wugong Shan, *J.S.Yue 3285* (PE); Yingtan, *Jiangxi Med. Exped. s.n.* (PE); Shangyou, *Jiangxi Exped. 0638* (PE); Jinggang Shan, *S.S.Lai 5025* (FUS); Xinning, *Y.B.Luo 3233* (PE). **Shaanxi:** way from Longwan to Shiquan, *B.Z.Guo 2133* (PE); Xixiang, *T.N.Liou & P.C.Tsoong 3969* (PE); Mianxian, *K.T.Fu 3936* (PE). **Sichuan:** Xiushan, *Xiushan Exped. 1136* (CDBI); Yaan, *Yaan Exped. 1047* (CDBI); Rongjing, *Rongjing Exped. 78-0724* (CDBI); Tianquan, *Tianquan Exped. 78–754* (CDBI); *W.P.Fang 3413* (PE); *K.C.Guan & W.T.Wang 3451* (PE); Hanyuan, *Hanyuan Exped. 0923* (CDBI); Eazu, *Dazu Exped. 0858* (CDBI); Dazhu, *Dazhu Exped. 0818* (CDBI); Xuanhan, *Xuanhan Exped. 0467, 0845* (CDBI); Kaijiang, *Kaijiang Exped. 0824* (CDBI); Daxian, *Daxian Exped. 0874* (CDBI); Youyang, *Youyang Exped. 1153* (CDBI); Wulong, *Wulong Exped. 1347* (CDBI); Pengshui, *Pengshui Exped. 1104* (CDBI); Mt. Emei, *T.T.Yu 23023* (PE); *G.H.Yang 57300* (PE); *C.W.Yao 5121* (PE, SZ); *W.P.Fang 3381* (PE); *14867* (SZ); *G.X.Xing & K.Y.Lang 1712* (PE); *W.P.Fang et al. 33431* (PE); *Y.H.Tao 51912* (SZ); Wuxi, *G.H.Yang 59502* (FUS, PE); Baoxing, *K.L.Chu 3821* (PE); *C.Pei 8245* (PE); Nanchuan, Jinfu Shan, *J.H.Xiong & Z.L.Zhou 93652* (PE, SZ); Guanxian, Qingchen Shan, *Z.R.Wu 33956* (PE); Zhaohua, *Y.Q.He 1704* (PE); Jincheng Shan, *Sichuan Econ. Pl. Exped. south group 89* (PE); Hefeng, *H.J.Li 8018* (PE); Leshan, *Z.T.Guan 6301* (PE); Chongqing, Beibei, *Z.L.Chou & Z.He 1392* (SZ); Fengjie, *Z.X.Gao & H.F.Zhou 26975* (SZ); Xuanen, *H.J.Li 4662* (SZ); no locality, *T.T.Yu 2565* (FUS); Chengkou, *T.R.Dai 102283* (FUS). **Zhejiang:** Lishui, *S.Y.Chang 6356* (FUS, HZBG, PE); Panshan, *T.N.Liou 8019* (PE); Siming Shan, *Y.Y.Ho 27528* (HZBG, PE); *27746* (PE); Changhua, *Y.Y.Ho 26318* (HZBG, PE); Tianmu Shan, *H.Q.Zhu 00377* (HZBG); *Y.Y.Ho 25368, 26318* (HZBG, PE); *25609* (HZBG); *Zhejiang Pl. Resources Exped. 28860* (HZBG,PE); Yandang Shan, *S.G.Chen 461* (FUS); Pingyang, *Y.Y.Ho 24736* (HZBG); *D.X.Zuo et al. 24644* (JSBI); Tiantai Shan, *Y.Y.Ho 27746* (HZBG); Suichang, *Zhejiang Pl. Resources Exped. 26878* (HZBG); Longquan, *Y.Y.Ho 21682* (HZBG); Jingning, *Y.Y.Ho 24289* (HZBG); Hangzhou, *S.Y.Chang 0659, 0857, 1202, 1448* (HZBG); Hangzhou Bot. Gard., cult., *J.Z.Lin 005, Z.Z.Yu 030* (HZBG).

JAPAN. **Chiba Pref.:** Awaamatsu, Kiyosumi-yama, *S.Kurita 84925* (CBM). **Kanagawa Pref.:** Hakone, *T.Sawada 2340* (TI). **Kyoto Pref.:** Yagi-cho, Hunai-gun, *G.Murata 19657* (PE). **Miyagi Pref.:** Sendai, Tomioka, *H.Hara s.n.* (TI). **Sagami Pref.:** Enoshima, *S.Momose 354* (PE). **Wakayama Pref.:** Nishimuroo-gun, Tanabe-cho, *J. Nakajima 15923* (TI); **Ooita Pref.**, Yabakei, *M.Togashi 7451* (TI); **Shiga Pref.**, Kohga-gun, Shigarakimachi, Asamiya, *H.Ohba et al. 9048* (TI). **Yamaguchi Pref.:** Kuniyoshiki-gun, Oouchimura, Yada, *S.Nikaido 107* (TI).

This distinctive species is characterized by its very narrow leaves, bright red flowers possessing narrow, strongly crisped-margined and recurved tepals, and the very much exserted stamens and styles.

This is probably the most widespread species of *Lycoris*. It occupies a large distribution area in China, mainly in the southern part of the Yangtze River. In Japan, it occurs everywhere except Hokkaido. The broad distribution of this sterile triploid is largely due to its strong vegetative reproduction-propagation carried on by the rapid formation of new lateral bulbs.

But this triploid *L. radiata* var. *radiata* resembles the diploid var. *pumila* Grey (see below) very much in gross morphology; they are difficult to differentiate one from another in the field or in herbarium. Accordingly, many of specimens

under the name *L. radiata* may actually be *L. radiata* var. *pumila*. The ecological preference of these two taxa, however, is quite different: *L. radiata* var. *radiata* grows usually in disturbed habitats such as edges of paddy fields, margins of plantations, waste places around dwellings, and graveyards, whereas *L. radiata* var. *pumila* grows in more natural habitats such as open slopes, shaded places by streams, sparse woods, etc.

With regard to the origin of this triploid *L. radiata* ($2n=33$), the most common way would be the hybridization of a diploid with a tetraploid. But because tetraploids have never been found in this species, Liu & Hsu (1989) suggested that *L. radiata* originated from the combination of an unreduced gamete of a diploid with a normal gamete of another diploid of *L. radiata* var. *pumila* ($2n=22$).

This sterile species was supposed to be an autotriploid (Inariyama 1951; Nishiyama 1928). Kihara & Koyama (1954) indeed obtained triploid offspring of *L. radiata* by self-pollination. But Kurita (1987c) argued that it is structurally heterozygous at least with regard to the satellite chromosomes and the four chromosomes carrying rather smaller short arms so far as somatic karyotype is concerned.

Koyama (1959), Kurita (1987c), and Maekawa (1943), suggested strongly that *L. radiata* var. *radiata* must have been originated in China and was introduced into Japan by people. The diploid *L. radiata* var. *pumila* occurs only in China and has never been found in Japan and elsewhere. *L. radiata* var. *radiata* has long been known as a hardy plant since ancient time, and usually occurs in habitats disturbed by people in both China and Japan. In America, it is cultivated outdoors in the southeastern states and on the Pacific coast.

A cultivar with white flowers has been reported. There is a picture of this cultivar in Creech's (1952) paper. Recently, a new form of *L. radiata* var. *radiata* was proposed by Yonezawa (1989): forma *bicolor*, the tepals of which were rose-colored and white-margined. The type specimens of this new form were all collected from Kyoto City of Honshu, Japan.

19b. Lycoris radiata (L'Hér.) Herb. var. **pumila** Grey, Hardy Bulbs 2:58. 1938.
Traub & Moldenke, Amaryllidac.: Tribe Amaryll. 178. 1949. TYPE: not indicated.

This fertile diploid taxon resembles var. *radiata* in external morphology and is very difficult to discriminate from it. So it is quite evident that many specimens cited under *L. radiata* var. *radiata* actually belong here.

Karyotype: $2n=22A=22$ (Bose 1958; Hsu et al. 1984; Inariyama 1951; Koyama 1962; Kurita 1987a; Liu & Hsu 1989; Nishikawa et al. 1979; Takemura 1962a; Yoshida 1972).

Distribution: endemic to China (Shaanxi, Henan, Anhui, Jiangsu, Zhejiang, Jiangxi, Fujian, Guangdong, Guangxi, Hunan, Hubei, Sichuan, Guizhou, and Yunnan). Often in open moist slopes, shaded wet places by streams, sparse woods,

and sandy flood lands; 50–1000 m in eastern, central, and southern China; to 2500 m in southwestern China.

This variety hybridizes with many other species of *Lycoris* and gives rise to fertile hybrids. According to Kurita (1987a), hybrids between this variety and *L. sprengeri* have been called "*L.* cv. *Sprenpumila*" and are well known to be fully fertile in spite of the morphological disparity of the parental taxa. Hybrids between *L. radiata* var. *pumila* and *L. chinensis*, *L. longituba*, or *L.* aff. *straminea*, have various rates of fertility (Lin et al. unpub.).

19c. **Lycoris radiata** (L'Her.) Herb. var. **kazukoana** Yonezawa, J. Phytogeogr. Tax. 37(2):73, fig. 1, 1989. TYPE: JAPAN. KYOTO PREF.: Honshu, Matsugasaki, Sakyoku, Kyoto City, *K. Yonezawa & N. Yonezawa s.n.* (HOLOTYPE: in Kana no. 130006); same locality, *N. Yonezawa 10100, 10120* (paratypes: in Kana nos. 130005, 130006).

This variety differs from var. *radiata* in its flowers being smaller and pale red or becoming whitish in color, and the tepals 1.5–3.2 cm long and 2–5 mm broad, only slightly reflexed.

Phenology: scape produced in late September to October.

Karyotype: no reports.

Distribution: endemic to Japan; 70–250 m.

20. **Lycoris ×rosea** Traub & Moldenke (pro sp.), Amaryllidac.: Tribe Amaryll. 178. 1949. Hsu et al., Fl. Reipub. Pop. Sin. 16(1):20, pl.4, fig. 5–6. 1985. TYPE: CHINA? Not cited or mention by Traub and Moldenke (l.c.).

Leaves strap-shaped, up to 44 cm long, 7–11 mm broad, rounded at apex, light green with an indistinct whitish stripe in the center. Scape 30–60 cm long. Perigone rose-colored. Tepaltube 1–1.2 cm long; tepals oblanceolate, 4–6 cm long, 7–8 mm broad, ruffled at the base, slightly recurved. Stamens exceeding tepals ca. 1/6.

Phenology: leaves emerging in autumn; scape produced in September.

Karyotype: $2n = 22A = 22$ (Hsu & Huang 1984; Liu & Hsu 1989).

Distribution: endemic to China (Jiangsu). In sparse second growth forest of low hills.

Specimens examined: CHINA. **Jiangsu:** Shanghai, Sheshan, *G.J. Fan s.n.* (PE); same locality, Hengshan, *Y. Hsu et al. 63918* (SHMI). **Zhejiang:** Hangzhou Bot. Gard., cult., *J.Z. Lin 004*(HZBG).

This species is characterized by its rose-colored flowers and by its stamens only 1/6 longer than the tepals. It is somewhat comparable to *L. radiata* var. *radiata* and var. *pumila*, but in those taxa the flowers are bright red and the tepals are narrower and strongly crisped-margined and recurved.

Lycoris ×rosea is most probably a natural hybrid. From the karyological point of view, Kurita is of the opinion that this species must be the hybrid of *L.*

radiata var. *pumila* (2*n*=22A) and *L. sprengeri* (2*n*=22A). His advocation is supported by Lin et al. (unpub.), who have made a crossing between the two taxa and as a result have brought forth a hybrid that is fertile and accords well in gross morphology with *L.* ×*rosea*.

EXCLUDED TAXA

Lycoris albiflora Koidz. cv. *Lactiflora*

Belongs to *L.* ×*albiflora* in its broad sense.

Lycoris "cinnabarina" (sphal. "*cinnabarinum*," a "catalog" name)

This species, reported only in cultivation, is very similar to *L. sanguinea* Maxim. Hunt (1963) referred it to be *L. sanguinea* var. *cyrtanthiflora* Hort. Caldwell (cf. Easterly 1969) said that it might turn out to be *L. kiusiana* Makino (= *L. sanguinea* Maxim. var. *kiusiana* (Makino) Koyama). Easterly (1969) reported the karyotype of *L. "cinnabarina"* to be 2*n*=21A+1M, slight different from that of *L. sanguinea*. Williams (1983), however, suggested that it was most likely to be a hybrid between *L. sanguinea* × *L. traubii*, with a karyotype of 2*n*=14T+4M=18.

Lycoris ×*elegans* Lin, Yu, & Hsu in S.A.He et al. (ed.), Proc. Intern. Symp. Bot. Gard. 565. 1990, nom. nud. =*L. sprengeri* ♀ × *L. chinensis* ♂ belongs to *L.* ×*albiflora* in its broad sense.

Lycoris flavescens M.Kim & S.Lee, Korean J. Pl. Taxon. 21:127. 1991.

This species is probably a hybrid between *L. sanguinea* var. *koreana* and *L. chinensis*.

Lycoris hyacinthina Herb., Bot. Mag. 47:t.2113. 1819 = *Griffinia hyacinthina* Ker-Gawl.

Lycoris ×*jacksoniana* Traub, Pl. Life 20:52. 1964 = *L. sprengeri* × *L. radiata* (probably var. *pumila*)

Lycoris josephinae Traub, Pl. Life 21:63. 1965, and 22:60. 1966.

The type material (*Traub 792*, holotype) was collected in Sichuan, China. According to the type description, there seems little difference in morphological characters deserving specific consideration between *L. josephinae* and *L. radiata*.

Lycoris ×*lajolla* Traub, Pl. Life 19:50. 1963 = *L. aurea* × *L. traubii*.

Lycoris radiata Miq., Ann. Mus. Bot. Lugduno-Batavum 2:139. 1865–66 = *Ungernia trisphaera* Bunge.

Lycoris sewerzowii Regel, Bull. Soc. Not. Moscou. 41:435. 1868 = *Ungernia sewerzowii* (Regel) Fedtsch. ex Vvedensky.

Lycoris ×*woodii* Traub & Moldenke, Pl. Life 13:85. 1957 = *L. radiata* ♀ × *L. traubii* ♂.

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